

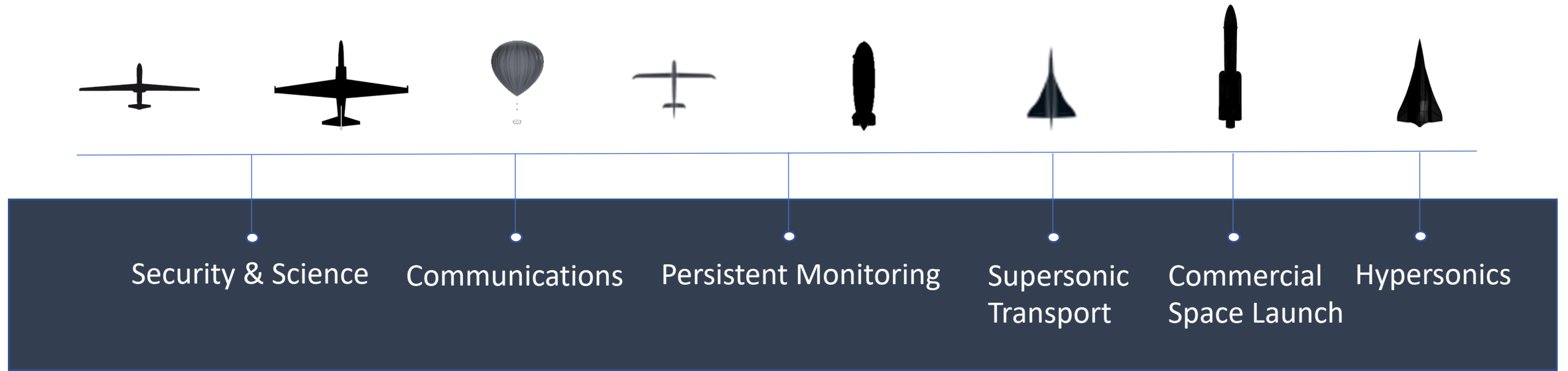


# EXPLORE FLIGHT

WE'RE WITH YOU WHEN YOU FLY

Airspace Integration – Upper Class E Traffic Management  
March 13, 2024  
SOaRS Symposium at UND

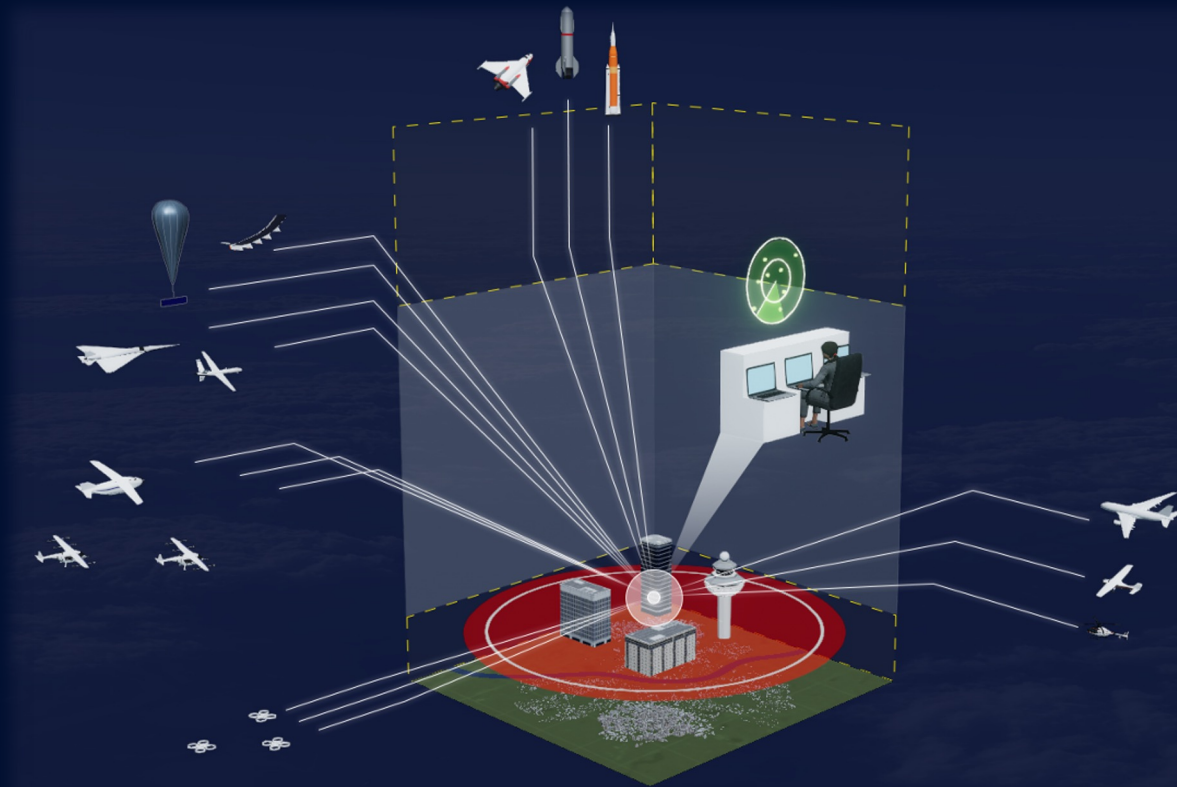
# Upper Class E Opportunities



- ❖ Demand for Upper Class E airspace use is projected to increase
- ❖ A diverse set of vehicle and operation types are expected
- ❖ Existing users need continued safety and access
- ❖ ATC services are limited in Upper E, which impacts the ability for industry to scale

# Extensible Traffic Management (xTM)

Catalyze airspace integration of diverse and scalable cooperative xTM operations



## Upper Class-E Traffic Management (ETM) Cooperative Operating Practices

*Develop functional requirements to support ETM operations of vehicles with unique performance characteristics and mission needs*



## ETM Cooperative Conflict Management

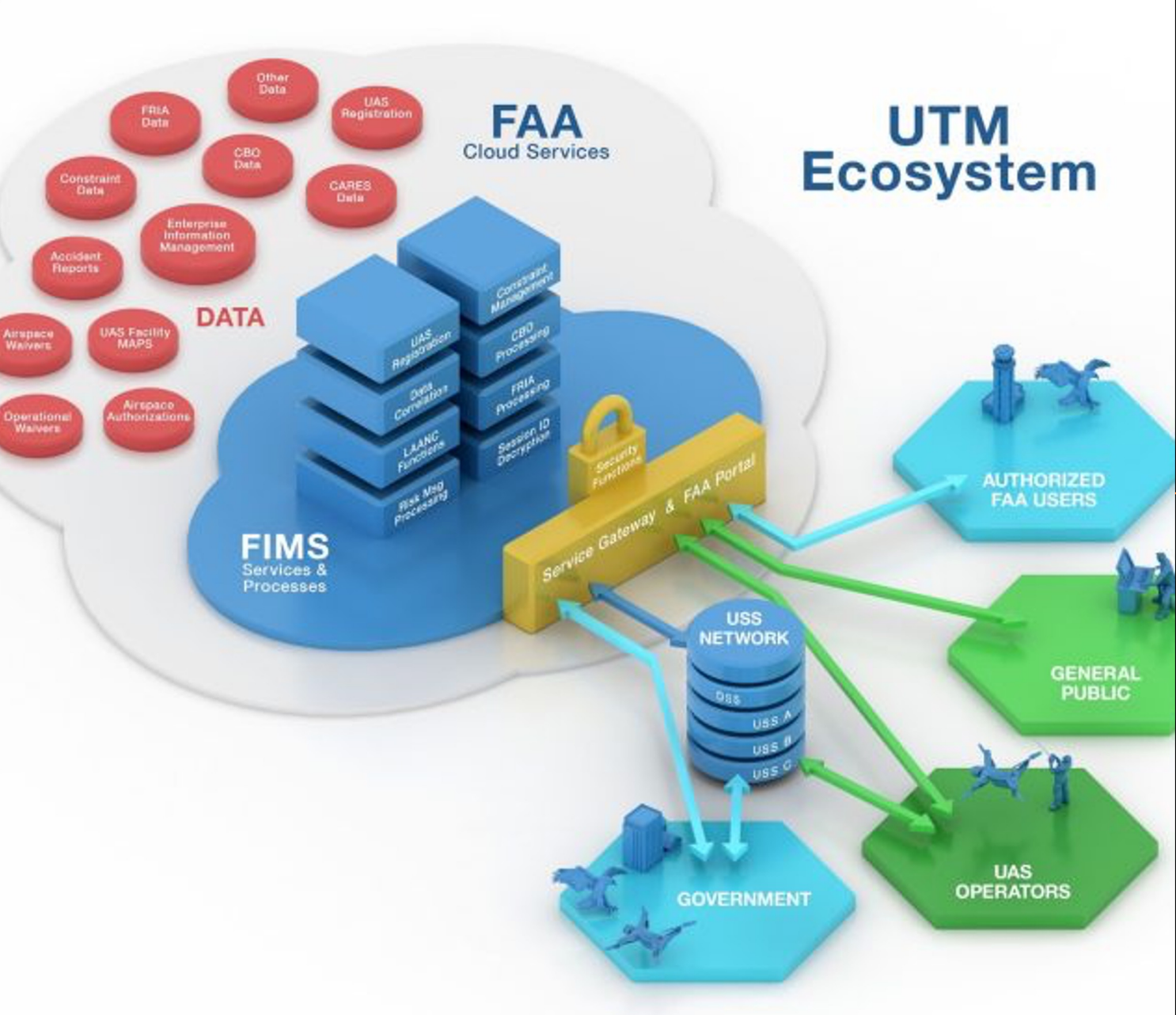
*Enable airspace integration through development of requirements for information sharing and conformance monitoring to enable cooperative separation*



## Operationalization of BVLOS for UTM

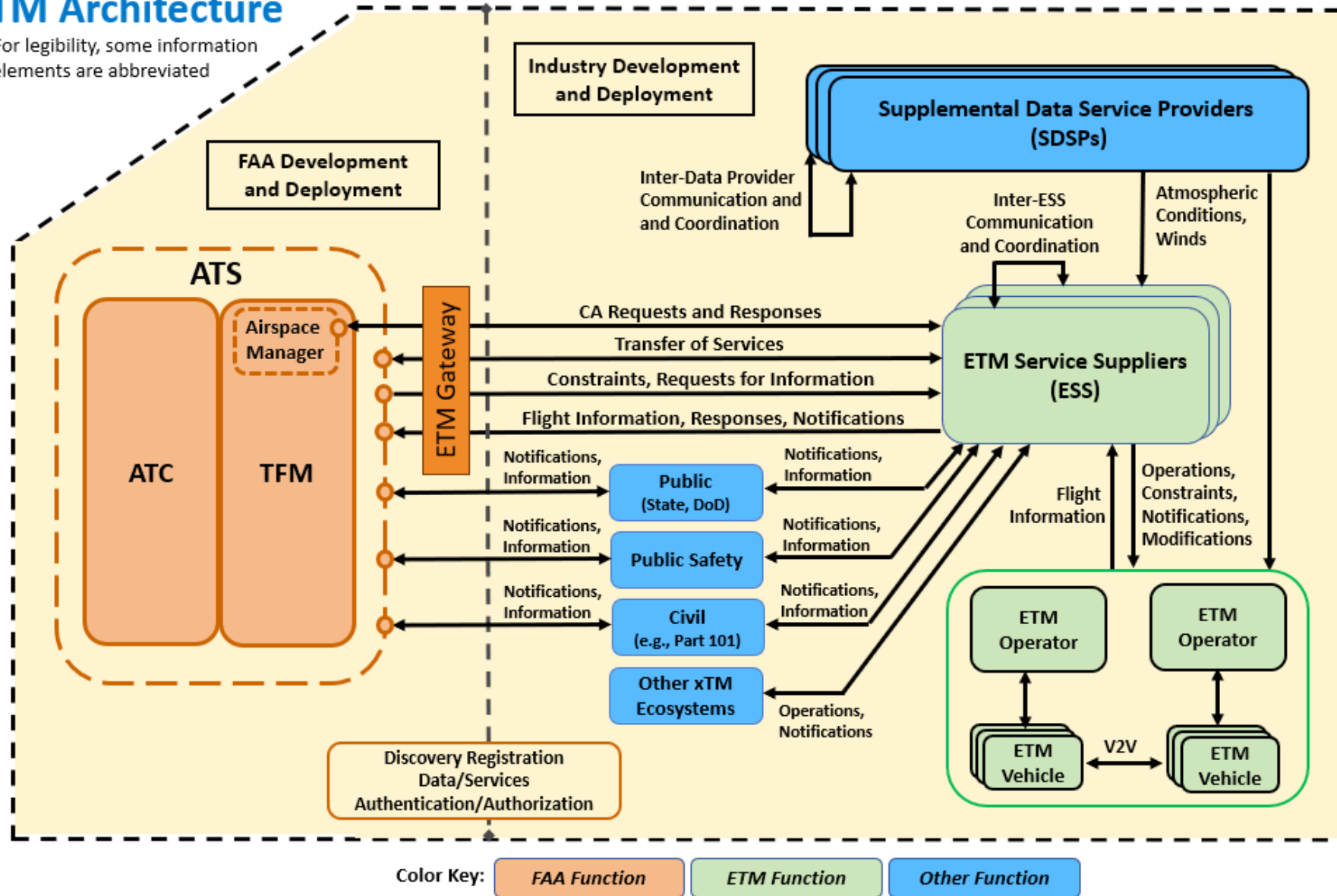
*Reinvigorate sUAS third party service and capability development to support BVLOS operation leveraging a UTM system*

# UAS Traffic Management (UTM) Framework



# ETM Architecture

\*For legibility, some information elements are abbreviated



# ETM Development

## Our History

### FAA-NASA-Industry Collaboration

\* 2020-Present Day: Regularly occurring NASA-led Meetings with Industry and FAA to discuss latest higher airspace developments (V

2019

*ETM Tabletop #1*  
April 18-19  
NASA Ames, CA

*Initial Discussions with Industry Stakeholders and FAA on Operational Needs and Principles for a Cooperative Traffic Management Concept*

*ETM Tabletop #2*  
December 12-13  
NASA Ames, CA

*Concept Development Focusing on Upper Class E Operator Interactions with Air Traffic Control*

2021

*ETM Workshop*  
July 21-22  
Virtual

*Informational Briefings on ETM Concept Development and Breakout Groups for Operators to Discuss Interactions with Each Other in ETM Environment*

2022

*ETM Guided Discussion #1*  
August 10-11  
Washington, DC

*Working Session with Industry Stakeholders to Develop an Initial Set of Cooperative Operating Practices (COPs)*

2023

*ETM Guided Discussion #2*  
January 10-11  
Virtual

*Working Session with Industry Stakeholders Focusing on COPs Development for Strategic Conflict Detection*

*ETM Guided Discussion #3*  
August 9-10  
NASA Ames, CA

*Working Session with Industry Stakeholders to Continue COPs Development*

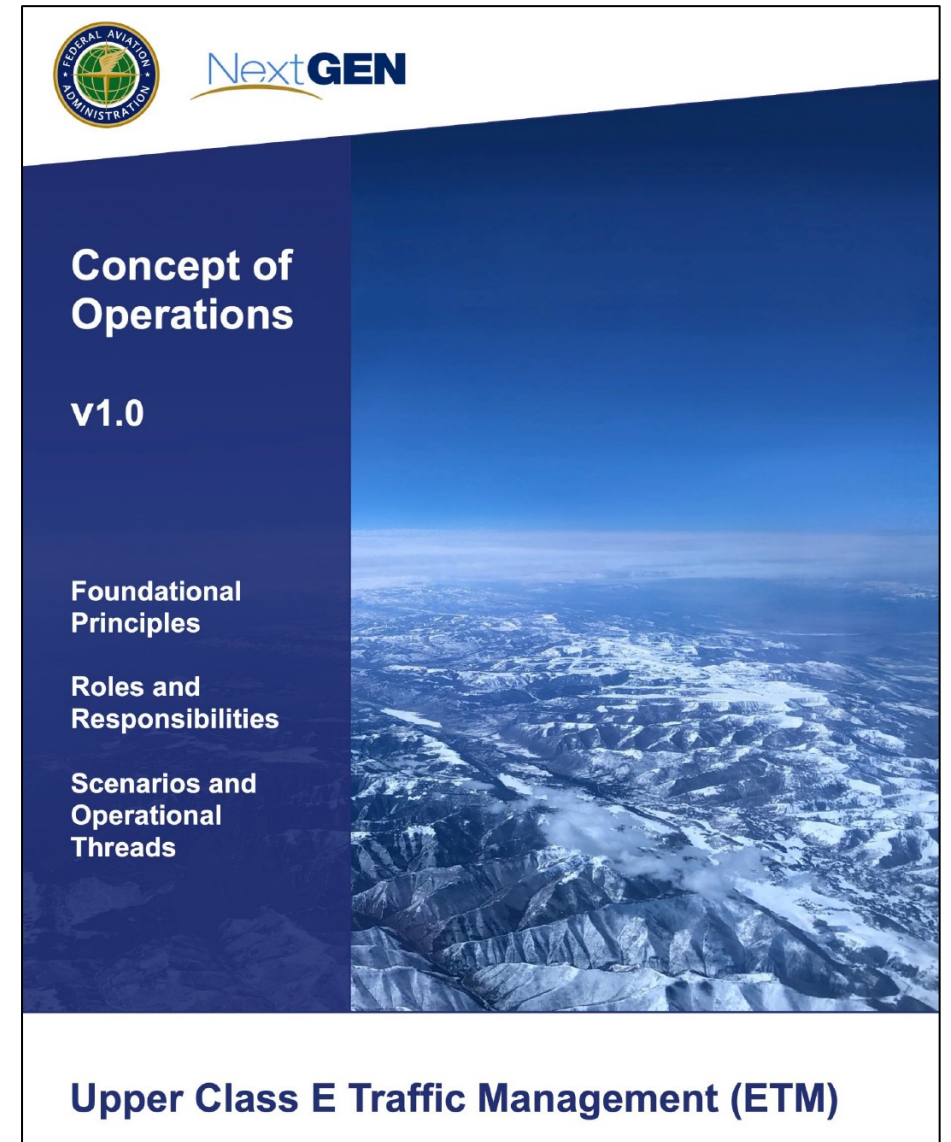
2024

*ETM Guided Discussion #4*  
March 12-13  
NASA Ames, CA

*Working Session with Industry Stakeholders Focusing on Operational Intent Sharing*

# ETM ConOps and Cooperative Operating Practice (COP)

- The ETM community interest and NASA, FAA, and industry activities led to the FAA publication of the initial Concept of Operations for Upper Class E Traffic Management (ETM) in May 2020.
- In the ConOps, ETM consists of two methods of separation management
  - Cooperative Separation
  - Air Traffic Control (ATC) Separation
- For Cooperative Separation, the operators are responsible for the coordination, execution, and management of the operation; this is to be conducted through Cooperative Operating Practices (COPs)



# NASA-Industry Collaborative Simulations

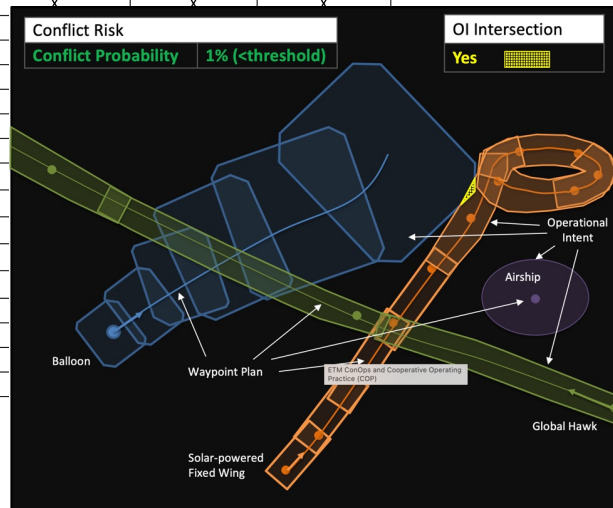
The First collaborative upper Class E traffic simulation (CE-1) with industry using the concept of Cooperative Operating Practice (COP) was announced in 2023

- ETM Research Roadmap was released
- New capabilities for risk-based operations and the ETM Service Supplier (ESS) are implemented
- Two industry partners (Aerostar and AeroVironment) are planning to participate the simulations
- Simulation and analysis report will be shared with industry
- First ESS API will be released after the simulations

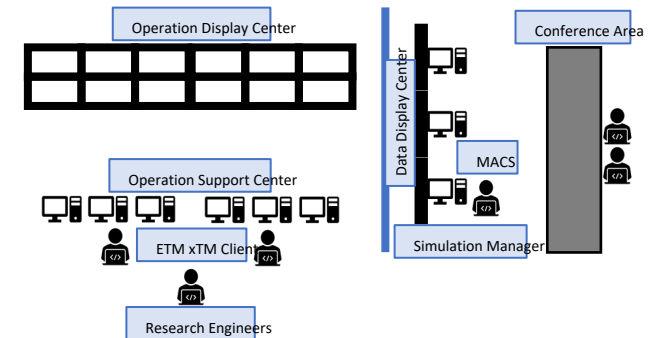
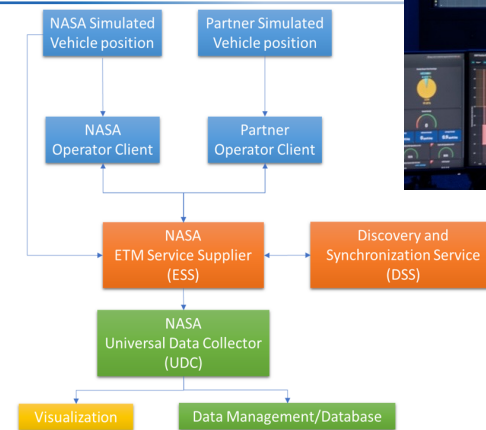


ETM Research Roadmap

Category	Functions	CE-1	CE-2	CE-3
ETM basic architecture	Cooperative Operating Practice procedure	X	X	X
Strategic conflict detection	Operational Intent Model	X	X	X
	Conflict Probability Calculation			
	Performance-based separation			
Strategic deconfliction	Fallback rules			
	Predefined agreements			
	Operational plan modification			
	Dynamic negotiation			
Conformance Monitoring	Operational state transition and transition criteria			
	Off-nominal procedures w.r.t Operational Intent			
	Off-nominal procedures w.r.t Cooperative Area			
	Advanced vehicle state estimation			
ETM-ATC interactions	Airspace traffic complexity			
	Cooperative Area Identification			
	ETM-ATC interactions procedure			
	ETM-ATC handoff HCI modeling, nominal case			
	ETM-ATC handoff HCI modeling, off-nominal case			



ETM System Architecture





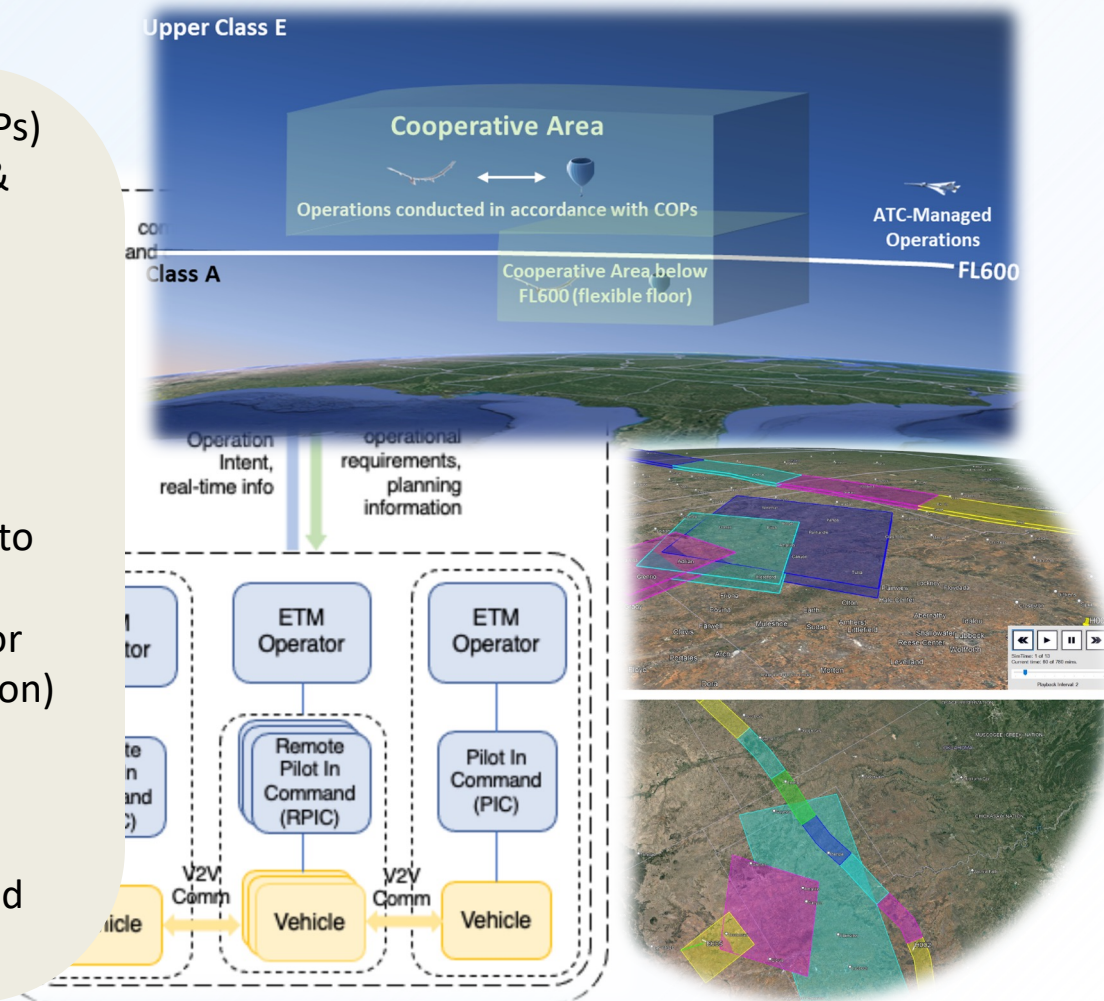
# ETM Cooperative Operating Practices & Conflict Management Progress



## NASA Collaboration with FAA & Industry

**Objective:** Collaboratively progress Cooperative Operating Practices (COPs) related to strategic conflict detection between high-altitude, uncrewed & slow High-Altitude Long Endurance (HALE) aircraft (balloon, airship, and fixed-wing)

- Jan 2023: ETM workshop with FAA and industry focused on the development of Cooperative Operating Practices (COPs) for strategic conflict detection and operational intent intersection
- Developed requirements and a prototype ETM service supplier (ESS) to support collaborative evaluation simulations with industry
- Signed SAA with AeroStar (actively operating high altitude balloons for missions and testing related to communication and science observation) to participate in upcoming simulations
- Aug 2023: Second ETM workshop held with multiple government agencies and industry focused on COPs for Cooperative Area management as well as transfer of services between an ATC controlled environment and a cooperative operating environment



Enabling diverse aircraft at high altitudes to collaboratively separate using agreed upon common operating practices and operational intent sharing requirements

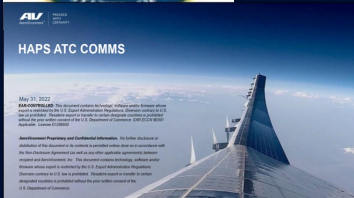
# Upper Class E Traffic Management Research

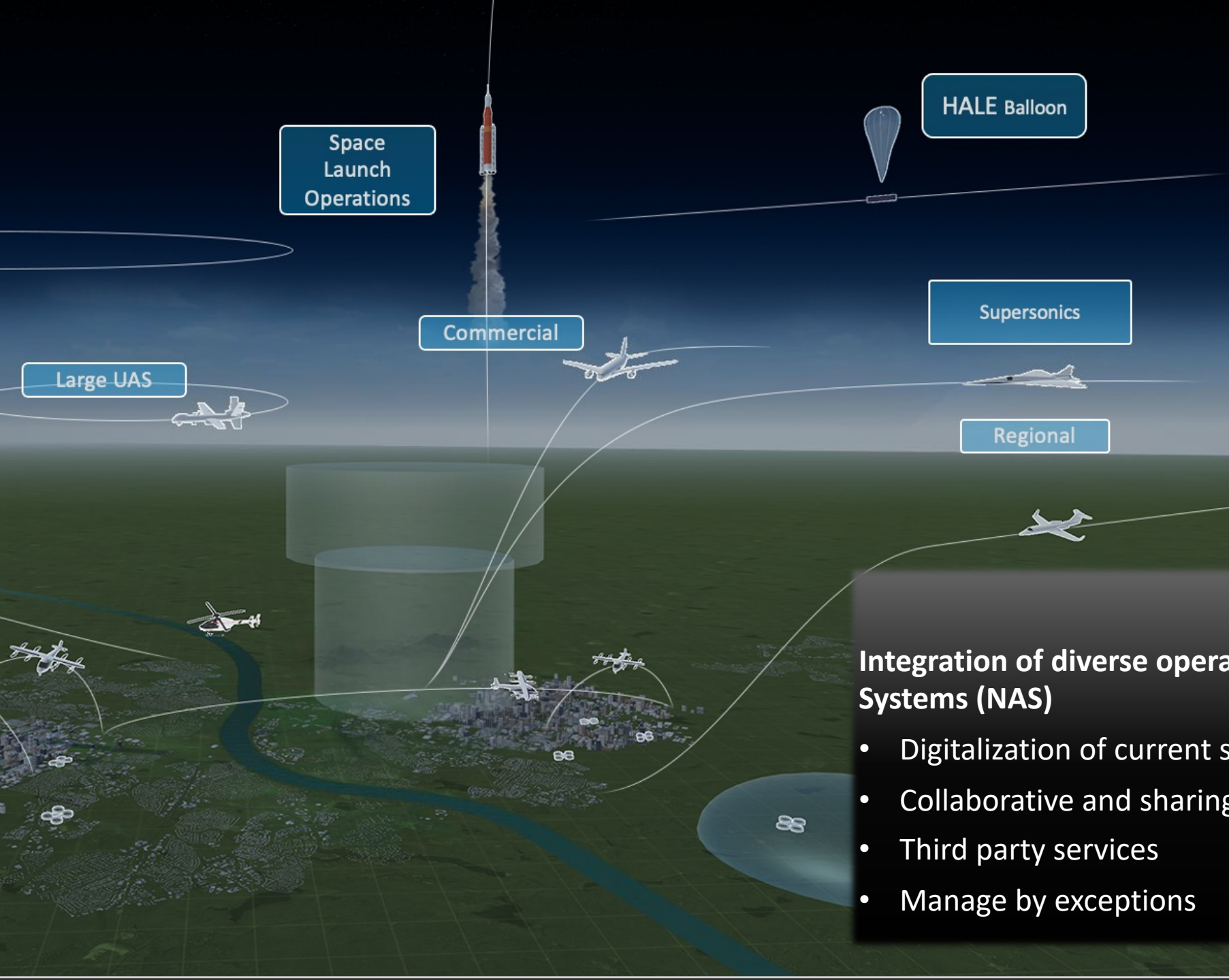
## ETM Cooperative Operating Practices

- Completed ETM RTT Joint Management Plan v1.1
- Completed two workshops with the FAA and industry to work toward identifying Cooperative Operating Practices for ETM
- Conducted Preliminary Experiment Review for a future ETM Cooperative Operating Practice simulation

## ETM Cooperative Conflict Management

- Completed a simulation of Upper-Class E traffic management deconfliction and negotiation, which included a novel approach to trajectory negotiation
- Delivered requirements for an ETM service supplier (ESS), which enables information exchanges to support the safe and efficient use of the airspace
- Completed an agency agreement with an industry partner for the ETM Collaborative Evaluation

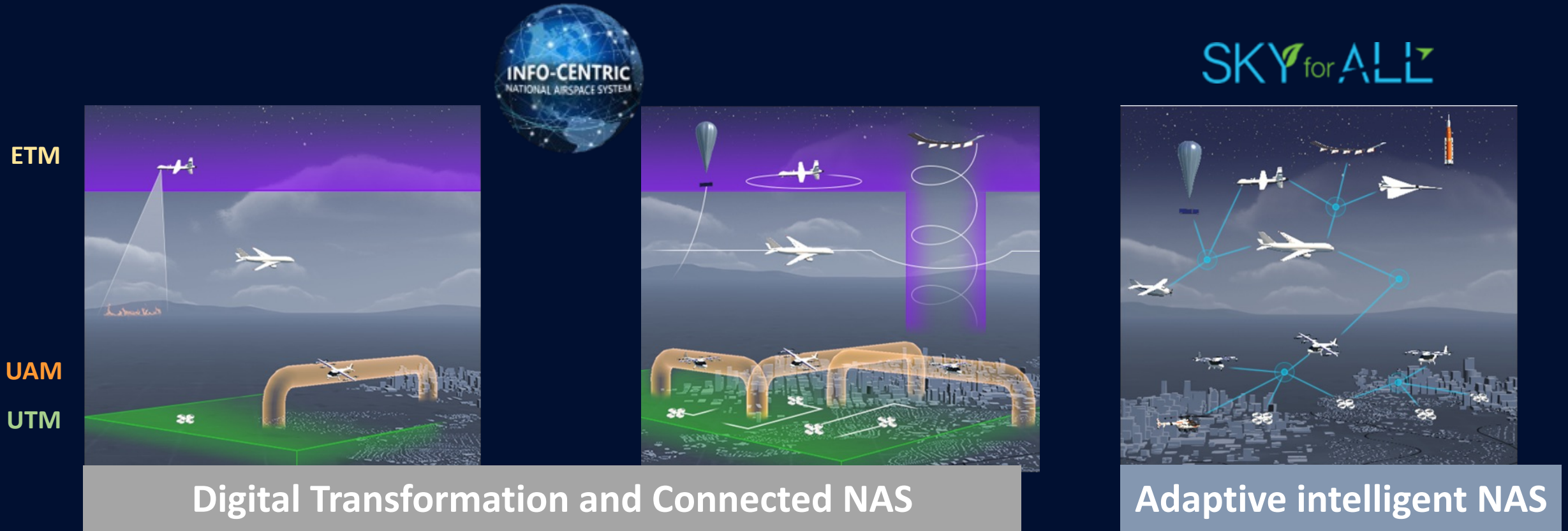




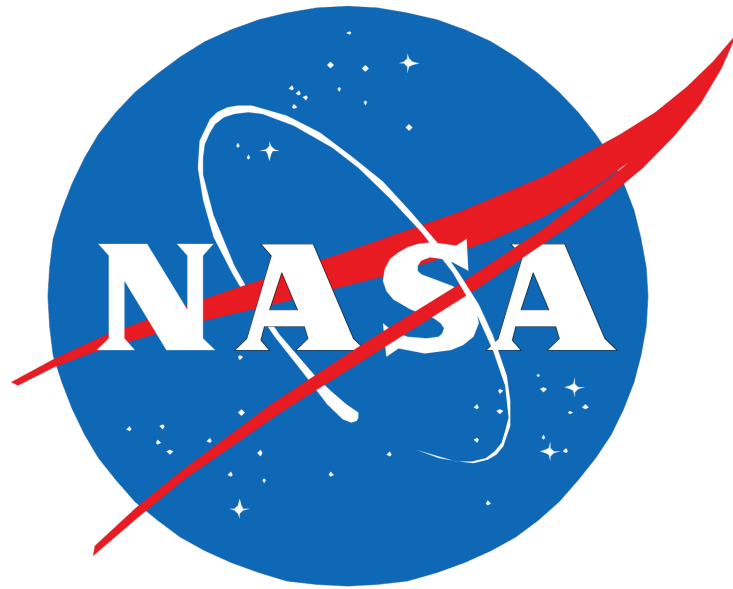
### Integration of diverse operations in the National Airspace Systems (NAS)

- Digitalization of current systems
- Collaborative and sharing Operational intent
- Third party services
- Manage by exceptions

# Pathway Towards xTM Integration



Develop scalable traffic management system for seamless introduction of new entrants while minimizing the impact on current operations



# NASA, FAA, and Industry Activities on ETM

- 2 NASA-hosted Tabletops in 2019
- NASA/FAA ETM leads have been engaging industry members for in-depth conversations
  - 1<sup>st</sup> ETM workshop, virtual, Jul. 21-22, 2021
  - Industry Tabletop, virtual, Jan. 10-11, 2023
  - 2<sup>nd</sup> ETM workshop, NASA Ames, Aug. 9-10, 2023
  - Quarterly tag-ups with industry (90 minutes), 2020-2023
  - Biweekly meetings between NASA/FAA engineering teams, 2020-2023
  - Monthly NASA/FAA RTT tag-ups since 2021
- NASA/FAA ETM Research Transition Team established in 2021
- Impacts: FAA published initial Con-Ops document V1.0

